ART. XV.—*A Treatise on the Pathology of the Urine, including a Complete Guide to its Analysis.* By J. L. W. THUDICHUM, M. D., with seven plates. London, John Churchill, 1858: pp. 429.

AMONG the special themes of study in the animal economy, none has attracted more attention, or produced a more voluminous literature, than urinary chemistry. It is, indeed, a tempting field of research. The fluid of which it treats is so easily obtained, and its relations to the general system are so obvious and so important, that it could hardly fail to force itself upon the notice of the student of physiology and pathology. There is but little danger that the importance of this study will be underrated. Our apprehensions are all in the other direction. One-sided studies are prone to lead their votaries to give undue prominence to them, to the neglect of other departments of inquiry.

Urinary chemistry has, indeed, specially manifested this tendency. Too exclusive deductions have been drawn from the condition of the discharges from the bladder. We have had brilliant theories built up on the foundation of the proportions of phosphates and chlorides passing away in the urine, and deductions affecting the most general considerations of pathology have been drawn from the determination of these salts. Yet we all know that a great quantity of phosphoric acid passes off through the intestinal canal, and there is no evidence against the supposition of a sort of complementary relation between the urine and feces in reference to the excretion of its salts, so that when deficient in the one they are in excess in the other. Urea, also, has been made the measure of the metamorphosis of nitrogenous matter in the body, and the physiological value of certain beverages has been deduced from the ratio of its diminution under their use. But why assume that urea is the only substance through which this waste gets exit? Why may we not as well infer that the change goes as far as ammonia, which is partly exhaled through the lungs, but chiefly passes off in the feces in the form of ammoniaco-magnesian phosphate. It is impossible to reason accurately with reference to any one function of the living body, until we know the state of all the others; so that it is absurd to attempt to build up a stately theory of diatheses upon the foundation of observations, however numerous and accurate, of the condition of a single secretion.

We are far from underrating the importance of the study of urinary chemistry. All we desire is that it shall be restricted within its proper limits, and that we shall not be led by science back to the point to which ignorance conducted our ancestors—to find all our pathology in a urinal. We hail any advances made in this department as contributions to the better understanding of the entire organism, but we ask that they may be checked by simultaneous observations of other excretions before they are received as interpretations of any general condition of the system.

It cannot be denied that, in spite of all the attention bestowed upon it, urinary pathology is still in a very unsatisfactory state. No one is more sensible of this fact than the careful and assiduous students of that medical speciality. It was, therefore, with no little satisfaction that we received the new treatise now under consideration. We must, however, caution our readers not to be misled by the title page. Those who expect to find an exclusive treatise on pathology, abounding in wire-drawn distinctions and brilliant speculations, are destined to disappointment. The order of the

book is that of a chemist, and it is a very full and satisfactory account of the present state of urinary chemistry and its relations to pathology. It entirely fulfils the author's promise in another clause of the title. It is truly a "Complete Guide" to the analysis of the urine. In this respect, we know of nothing in the language at all comparable to it. It is concise yet not obscure in its language and admirably lucid in its method. The author is manifestly thoroughly acquainted with the literature of his subject, and well versed in the manipulations of which he treats. He is no theorist, and has no hobbies to ride. Consequently, we have, as a result, a minimum of speculation and a maximum of fact.

We shall not attempt an analysis of a book which has so little superfluous matter. A running commentary on those points which particularly arrested our attention during the perusal of the volume may serve to give our readers an idea of its character, and for the rest we must refer them to the work itself.

The author begins with an account of the physical characters of the urine, under which head its clearness or turbidity, its odor, taste, and tints are discussed. For the latter, Vogel's scale is adopted and illustrated by a colored plate. A very useful table is also introduced in which the causes of each hue, and the most expeditious tests for its peculiar coloring matter, are given. In this also are included the tints imparted by the various foreign substances which reach this excretion through the medium of the circulation.

In reference to the vexed question of the acid reaction of the urine, the author is not quite so full as could be wished, and leaves the matter pretty much as he found it, attributing it in one place to the acid phosphates and in another acknowledging the presence of an unknown free acid. Lehmann's experiments with the baryta salts show conclusively that the acid phosphates are not always the sole cause of this reaction, which, he thinks, may also be attributed to hippuric and lactic acids. Our author gives Neubauer's formula for the estimation of this unknown free acid, oxalic acid being taken as the standard of acidity. This portion of the chemistry of the urine is in an extremely unsatisfactory state. The changes of the urine are briefly noticed. Allusions to Scherer's researches on acid reaction are scattered over various chapters, but we were disappointed in finding no continuous discussion of them in this place, where some account of acid fermentation was to be expected.

The question of alkalinity is more fully discussed. This is well known to depend upon fermentation within the bladder, when not caused by alkaline ingesta. The carbonate of ammonia, thus formed, gives rise to all the bad consequences of precipitated phosphates. In a note to this chapter the author gives some excellent practical hints in reference to the selection and preparation of test-paper.

Concerning the collection of the urine, and the determination of its quantity, we have some very sensible remarks. Great stress is laid upon the absolute necessity of accuracy in this particular, and, indeed, without it, the most elaborate analyses are of little value. To determine the pathological and physiological significance of any particular ingredient in the urine, it is imperatively necessary to know, not merely its *per mille* proportion, but the actual amount discharged in a given time. It is to stand as an index of waste or absorption, and any statement of mere proportion gives us no definite information. The relative proportion of water and solids may vary; so, also, there may be a difference in the relations of the latter to one another,

or a particular solid of grave pathological importance may owe its entire significance to its absolute quantity and its constant production.

The rules given for the determination of the solids are excellent. The method of evaporating the urine by heat is highly objectionable, because the acid phosphate of soda constantly decomposes the urea, giving rise to carbonate of ammonia, which passes off with the watery vapour. An accurate determination of the separate solids, therefore, cannot be made to correspond, in its amount, with the total weight as obtained by drying in this manner. The best method is unquestionably to evaporate over some hygroscopic substance *in vacuo*, and, indeed, this is the only plan admissible in any delicate analysis of organic substances. The direction of our author, to keep the vessel containing the solid residue hermetically sealed during the process of weighing, is by no means to be despised, as these organic bodies so rapidly absorb water from the atmosphere, that it is impossible to keep the weight constant long enough to determine it with accuracy.

The attempt to estimate the total weight of solids from the specific gravity of the liquid is utterly futile. Our author very clearly sets forth the amount and cause of the error in this method, even when the greatest precautions are taken. The ordinary mode of taking it renders any approach to accuracy absolutely impossible, the inevitable mistake being multiplied by the unknown quantity, carelessness in the operator. A plan of estimation which is liable to a necessary error of one-tenth of the entire amount of material estimated during health, and one-fourth during disease, has certainly no claims to anything like accuracy. The gravimeter, therefore, must be considered as a very rude and imperfect instrument of research, capable of giving some clinical information, but utterly worthless in the decision of all questions which require delicacy of determination. All inferences as to waste of tissue, which may have been drawn from observations made with it, must be ruthlessly rejected.

The chemical history of the various constituents of the urine commences naturally enough with urea. The instructions for its detection and determination are very explicit. To avoid the disadvantages of coagulating by heat albuminous fluids in which urea is to be sought, the plan of extraction with absolute alcohol is recommended. This agent, at the same time that it coagulates the albumen, dissolves the urea.

The method recommended by our author for the quantitative determination of urea is that originally devised by Liebig. This, as is well known, is accomplished by precipitating the urea with a solution of nitrate of mercury of known strength. Great care is necessary in the preparation of the reagents for this purpose, and the most minute directions are given by our author, guarding the student against every possible source of error.

Bunsen's method of determining the amount of urea, by the quantity of carbonate of baryta formed during its decomposition at the temperature of an oil-bath, is also given. This is the most elegant and accurate of all chemical methods for urea, none of the other constituents of the urine being similarly affected.

Davey's plan, which is also described, is objectionable, because uric acid is liable to the same change with urea. It consists in treating urine in a graduated vessel with hypochlorite of soda, the amount of urea being estimated by the quantity of nitrogen gas evolved. This plan is liable still further to the objection which lies against all volumetrical determinations of gases, as being too delicate for the common use of the profession. So many and so careful corrections must be made for temperature, barometric

pressure, &c., that it is a hopeless task for the medical practitioner to undertake.

The physiology and pathology of urea are very briefly stated. It is assumed to be the measure of "dissimilation," a term coined by the author to express the opposite of assimilation, but not synonymous with the common phrase "retrograde metamorphosis," inasmuch as it implies a change which may be effected in food as well as in tissue. Nothing is said of its relations to uric acid, and no positive theory of its origin is hazarded. In a subsequent chapter, on albumen, Bechamp's statement that urea is formed from albumen, by digestion in hypermanganate of potash, is repeated. Staedeler, however, has recently contested this discovery, insisting that Bechamp's urea is nothing but benzoate of potash.

For the precipitation of uric acid, nitric acid is recommended in preference to hydrochloric, on account of the greater solubility of the substance sought in the latter acid, as well as the increased tendency to the formation of confervoid growths which decompose the acid, a process entirely prevented by the use of nitric acid. For the volumetrical determination of this substance, Scholz's process with permanganate of potash is recommended. This is so uncertain, that no analytical chemist would be satisfied with a process for the determination of the commercial value of an article which was half so inaccurate. Nothing shows more conclusively the unsatisfactory condition of organic analytical chemistry than the expectation expressed by our author that two inevitable errors will balance one another. For the diagnosis of urates, a very simple table is given, perfectly unexceptionable, so long as they are found separately. The caution in reference to the necessity of dissolving the deposit in boiling water and filtering whilst hot, is necessary to be borne in mind when making these comparative tests.

The remarks on deposits of urates and of uric acid are well worthy of attention. They are very full and cover the whole ground. The precise pathological value of these sediments is carefully examined. Uric acid diathesis is rejected as a useless pathological myth, the presence of deposits being attributed to acid fermentation. The development of lactic acid by the action of a mucous ferment on the colouring matter, and the consequent decomposition of the urates, as shown so satisfactorily by Scherer, is adopted by our author, and has, indeed, gained very general acceptance from those who have studied the subject.

Under the head of creatine and creatinine we find nothing new, except some experiments to determine the quantities of these substances excreted.

In the chapter on chlorine we have some sound remarks on the errors inseparable from the method of estimating the salts by evaporation and incineration. In all organic analyses it is a growing conviction among chemists that incineration effects such changes as totally to mislead us in reference to the true constitution of their saline ingredients. Decomposition is inevitable, and no human ingenuity can rearrange the disturbed elements in their original order. In the volumetrical analysis of chlorine, preference is expressed for the method by nitrate of mercury, because the end of the precipitation is indicated by a change of colour, whereas, in the nitrate of silver process, it is only determined by the cessation of a cloudiness. This is easily obviated by adding a chrome salt to the urine, which, by the permanent crimson precipitate, indicates the moment at which all the chlorine is thrown down.

Physiologically, chlorine has a direct relation to vital activity. The greater that is, the larger is the amount of chlorine excreted by the kidneys.

Let the activity be either nervous or vascular, the result is the same. Indeed, copious draughts of water, which, in common parlance, stimulate the kidneys, produce the same result. This, however, looks to us more like a physical than a vital action. If we compare the tissues to a porous filter charged with saline matter, we shall find no cause of surprise in the fact that a large and long-continued current of water, passing through their pores, will wash out more salt than a smaller quantity occupying less time in the transit. Barral's idea of chlorides stimulating the elimination of nitrogen may possibly be accounted for in the same way, since they excite undue thirst and lead to copious draughts of liquids.

As for its pathological significance, the result of numerous observations is that chlorine is always diminished in acute febrile diseases, sometimes falling as low as one-hundredth of the normal quantity. Indeed, so constant is its relation to the pathological state of the system that it may be used as a prognostic, its decrease being an evidence of increasing morbid action, and its progressive augmentation affording a measure of convalescence.

Sulphuric acid has been observed to be increased when an exclusive meat diet has been used. There is no doubt that it arises in great part from the oxidation of albuminous materials, whether existing as tissues or introduced as food. The absence of this acid in muscle-juice seems to imply that the ultimate oxidation takes place either in the course of the circulation, or in the very act of secretion in the kidneys. Here, however, all is yet dark, and many more observations are needed to determine this question.

Phosphoric acid, as every body knows, is a constant and most important ingredient of the urine. The methods given for determining it (by acetate of soda and iron) are not satisfactory, and, indeed, at present there are difficulties surrounding every process for its estimation. The author himself acknowledges that the plan recommended is liable to an error of ten per cent. in the most careful hands, which may rise to twenty or thirty, should the operator be a little careless. Few chemists who have used it to any extent, have much partiality for it. Perhaps Kopp's plan of precipitating as yellow phosphate of uranium may succeed better. The common method of throwing it down as a double salt of ammonia and magnesia cannot be relied upon at all, when delicacy is desirable.

In speaking of the physiological signification of the acid, our author notices its relation to the ingestion of food, but is strangely silent in regard to the influence of the disintegration of nervous matter upon the quantity secreted.

The few paragraphs in which the pathological indications of albumen in the urine are indicated, are very brief but very much to the point. They contain, in a form perhaps too condensed for the ordinary student, a summary of what is known upon the subject, without any admixture of speculation. The general medical reader knows how very little that is.

There is an equal economy of language and speculation in the chapter on sugar, and, perhaps, some readers may complain of the *ex cathedra* manner in which vexed questions are decided upon. For example, Mialhe's notion of the influence of alkaline bicarbonates on the oxidation of sugar, is simply denied, without argument. With equal peremptoriness is Bernard's idea of the formation of sugar from albuminous substances in the liver disposed of; the presence of sugar in that organ, among the carnivora, being attributed to the inosite of the flesh they eat. Singularly enough, this is a question not touched upon in the controversy on glucogenia. The nearest approach to it is Lehmann's search for a glucoside which he con-

ducts with diastase and sulphuric or hydrochloric acid, neither of which acts upon inosite. In any event, however, this does not affect the opinion that the liver is the special organ for the formation of sugar; it only changes the raw material from which the glucose is to be made. Our author suggests that the milk-sugar in carnivora may be formed from inosite. The odour of diabetic urine is attributed to acetone, on the strength of the examination of a case in the hospital, at Prague.

Under the head of uroxanthine, we have great light shed upon a number of obscure cases in which a blue colouring matter, resembling indigo, has been observed in the urine. The observations of Kletzinsky and Schunck are cited to show the identity of indigo blue and indigo red with Heller's uroglaucin and urrhodin; and of indican (the substance which by oxidation yields indigo) with uroxanthine. The result appears to be that indican is an ingredient of normal urine, and the formation of indigo from it is only one of the accidents of oxidation. Virchow was able to make indigo from every specimen of concentrated urine he examined.

In treating of oxalate of lime, our author goes into a very full investigation of the crystallographic forms of that substance, and concludes that it belongs to the quadratic and not to the cubical system. He differs wholly from Golding Bird's second opinion concerning the dumb-bells, and restores them to their original position among the forms of oxalate of lime.

The book concludes with an account of urophanic substances, or those which, when introduced into the body, are expelled through the urine. There are many interesting observations in this chapter, but to discuss them would extend this notice to too great a length. A. S. P.